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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the manufacture approach of the lighting system used in order to manufacture various devices, such as display devices, such as image pickup devices, such as semiconductor devices, such as IC and LSI, and CCD, and a liquid crystal panel, and the magnetic head, especially, the projection aligner equipped with this, and a semiconductor device about the projection aligner equipped with a lighting system and it.
[0002]
[Description of the Prior Art] In recent years, further detailed-izing and high integration of semiconductor devices, such as IC and LSI, are advancing, and the very high optical-character ability of 0.2 micrometers or less in the minimum line width on a wafer side is demanded of the projection aligner used for manufacture of the semiconductor device concerned in connection with it.
[0003] Generally, in case the circuit pattern on a reticle side is projected on a wafer side (plane of projection) through projection optics, with wavelength of the light source, NA (numerical aperture) of projection optics, etc. to be used, the homogeneous quality of the illumination distribution on plane of projection-ed is large to an exposure result, and the resolution of a circuit pattern has influenced.
[0004] If minimum line width will call it 0.2 micrometers or less especially, it is requested that the ArF excimer laser (wavelength of about 193nm) of short wavelength etc. is mentioned to the candidate as the light source, and there is illuminance nonuniformity to less than about 1% as homogeneity of the illumination distribution on plane of projection-ed.
[0005] Drawing 13 is the important section schematic diagram showing an example of the optical system of the conventional projection aligner. In this drawing, the illumination light from the light source 71 condenses according to optical system 72, and carries out incidence to plane-of-incidence 73a of the optical integrator 73 which arranged two or more microlenses two-dimensional. And two or more secondary light sources are formed in injection side 73b of the optical integrator 73. The illumination light from two or more secondary light sources formed in injection side 73b condenses and overlaps by the condenser lens 74 respectively, and illuminates a field 75.
[0006] On the field 75, the reticle R in which the predetermined circuit pattern was formed is arranged, and the circuit pattern on the Rth page of a reticle carries out projection image formation on the plane of projection 77-ed of Wafer W with the projection lens 76. At this time, the secondary light source of injection side 73b of the optical integrator 73 is formed near the pupil 76a of the projection lens 76 of a condenser lens 74.
[0007]
[Problem(s) to be Solved by the Invention] Since the illumination distribution in the plane of incidence of each microlens which constitutes the optical integrator 73 overlaps on the plane of projection 77-ed and the plane of projection 77-ed is illuminated when the above configurations are taken, the homogeneity whose illuminance nonuniformity is several % - about 10% as illumination distribution on the plane of projection 77-ed is attained. However, it is difficult to fill the request of less than

[illuminance nonuniformity 1%] only with contribution of the optical integrator 73.
[0008] As a factor which illuminance nonuniformity generates, various things, such as dust, dirt, etc. within the eccentricity of a light source distribution configuration, or the light source and optical system, the nonuniformity and the thickness error of coating, the permeability difference by the bending mirror or the half mirror, and optical system, can be considered.
[0009] Then, in the conventional projection aligner, in order to change the ratio of the illuminance of the circumference to a shaft top Two or more condenser lenses from which distortion aberration (distortion) differs are prepared. Use it for every projection aligner, choosing the optimal condenser lens, or The condenser lens was constituted from a zoom lens, it adjusted and the location of the light source or optical system was adjusted as a means to adjust the inclination component (inclination nonuniformity: nonuniformity, like the right is high to the left) of illuminance nonuniformity so that it might become the optimal illuminance nonuniformity according to a case.
[0010] However, these preparation had the fatal fault that the image formation engine performance in plane of projection-ed will change, by using the aberration and eccentricity of the optical system itself and adjusting illuminance nonuniformity.
[0011] The purpose of this invention is to offer the lighting system which can stop small the illuminance nonuniformity in an irradiated plane (plane of projection-ed), and can attain uniform illumination distribution, without performing eccentricity of optical system etc.
[0012] Moreover, the purpose of this invention is to offer the projection aligner which makes it possible to have said lighting system, to stop the illuminance nonuniformity in an exposure side small, to attain uniform illumination distribution, and to fully correspond to minute micro processing demanded.
[0013]
[Means for Solving the Problem] The lighting system of this invention is a lighting system which irradiates the illumination light at an irradiated plane, has the closed space where the optical path lengths differ with the location through which said illumination light passes, and adjusts the illumination distribution on said irradiated plane by changing the state of matter which constitutes the fluid in said closed space.
[0014] The example of 1 mode of the lighting system of this invention has a means to acquire the illumination distribution information on said irradiated plane, and changes the state of matter which constitutes the fluid in said closed space based on said illumination distribution information acquired by said means.
[0015] In the example of 1 mode of the lighting system of this invention, it is the gas in which the fluid in said closed space has the property which absorbs said illumination light of predetermined wavelength.

[0016] The example of 1 mode of the lighting system of this invention has two or more said closed space, and may change independently the state of matter which constitutes inner each fluid of said closed space.
[0017] The lighting system of this invention is a lighting system which irradiates the illumination light at an irradiated plane, and adjusts the illumination distribution on said irradiated plane by changing the wavelength of said illumination light.
[0018] In the example of 1 mode of the lighting system of this invention, the illumination distribution information on said irradiated plane is acquired, and the illumination distribution on said irradiated plane is adjusted to a request condition based on the illumination distribution information concerned.
[0019] The lighting system of this invention is a lighting system which irradiates the illumination light at an irradiated plane, and adjusts the illumination distribution on said irradiated plane by changing the condition of the fluid which consists in the optical path of said illumination light.
[0020] In the example of 1 mode of the lighting system of this invention, the illumination distribution information on said irradiated plane is acquired, and the illumination distribution on said irradiated plane is adjusted to a request condition based on the illumination distribution information concerned.
[0021] In the example of 1 mode of the lighting system of this invention, it is the gas in which said fluid has the property which absorbs said illumination light of predetermined wavelength.

[0022] The projection aligner of this invention is equipped with said lighting system, and is exposed by projecting a predetermined pattern on the wafer side which is said irradiated plane.
[0023] The lighting system of this invention is a lighting system which points to the light from the light source in an irradiated plane through optical system, and controls the ratio of the ambient atmosphere component within a part of [at least] optical system among said optical system based on the illuminance or illumination distribution information on said irradiated plane.
[0024] controlling an oxygen density in the example of 1 mode of the lighting system of this invention -- the ratio of said ambient atmosphere component -- controlling .
[0025] In the example of 1 mode of the lighting system of this invention, said light source contains the light of the wavelength of 192nm - 194nm within the limits.
[0026] In the example of 1 mode of the lighting system of this invention, said light source is an ArF excimer laser.
[0027] In the example of 1 mode of the lighting system of this invention, wavelength of said light source is made adjustable.
[0028] The projection aligner of this invention is equipped with said lighting system, and is exposed by projecting a predetermined pattern on the wafer side which is said irradiated plane.
[0029] In the example of 1 mode of the projection aligner of this invention, the oxygen density within a part of [said / at least] optical system is controlled based on the illumination distribution information and light exposure information on said wafer side.
[0030] The lighting system of this invention has the closed space constituted so that the absorption coefficient of said illumination light might change with locations through which the light source which emits the illumination light, and the fluid which has at least the property which absorbs said illumination light in the interior are enclosed, and said illumination light passes, is equipped with the optical system which makes it point to said illumination light to an irradiated plane through this closed space, and adjusts the illumination distribution on said irradiated plane using said absorption coefficient difference of said illumination light.
[0031] In the example of 1 mode of the lighting system of this invention, the illumination distribution on said irradiated plane is adjusted by changing the state of matter which constitutes said fluid in said closed space.
[0032] In the example of 1 mode of the lighting system of this invention, the illumination distribution on said irradiated plane is adjusted by changing the wavelength of said illumination light.
[0033] In the example of 1 mode of the lighting system of this invention, said optical system has said closed space with the lens group which makes it point to said illumination light to an irradiated plane, and is equipped with the amendment optical system which it comes to allot independently of said lens group.
[0034] In the example of 1 mode of the lighting system of this invention, said optical system is equipped with the lens group which makes it point to said illumination light to an irradiated plane, and said closed space is formed between the predetermined lenses which constitute the lens group concerned.
[0035] The example of 1 mode of the lighting system of this invention is further equipped with a detection means to detect the illumination distribution information on said irradiated plane, and an amendment means to change the state of matter which controls said optical system and constitutes said fluid in said closed space according to said illumination distribution information from said detection means.
[0036] The example of 1 mode of the lighting system of this invention is further equipped with a detection means to detect the illumination distribution information on said irradiated plane, and an amendment means to control said light source and to change the wavelength of said illumination light according to said illumination distribution information from said detection means.
[0037] In the example of 1 mode of the lighting system of this invention, it is the mixture of gas in which said fluid contains oxygen, and the illumination distribution on said irradiated plane is adjusted by changing an oxygen density.
[0038] The example of 1 mode of the lighting system of this invention has two or more said closed

space, and may change independently the state of matter which constitutes inner each fluid of said closed space.

[0039] The lighting system of this invention has the closed space constituted so that the absorption coefficient of said illumination light might change with locations through which the light source which emits the illumination light, and a gas with the property which absorbs said illumination light at least are enclosed with the interior, and said illumination light passes. The optical system which makes it point to said illumination light to an irradiated plane through this closed space, It has a detection means to detect the illumination distribution information on said irradiated plane, and an amendment means to change the concentration of said gas in said closed space, and to adjust the illumination distribution on said irradiated plane according to said illumination distribution information from said detection means.

[0040] The lighting system of this invention has the closed space constituted so that the absorption coefficient of said illumination light might change with locations through which the light source which emits the illumination light, and a gas with the property which absorbs said illumination light at least are enclosed with the interior, and said illumination light passes. The optical system which makes it point to said illumination light to an irradiated plane through this closed space, It has a detection means to detect the illumination distribution information on said irradiated plane, and an amendment means to control said light source, to change the wavelength of said illumination light according to said illumination distribution information from said detection means, and to adjust the illumination distribution on said irradiated plane.

[0041] The lighting system of this invention has the closed space constituted so that the absorption coefficient of said illumination light might change with locations through which the light source which emits the illumination light, and a gas with the property which absorbs said illumination light at least are enclosed with the interior, and said illumination light passes. The optical system which makes it point to said illumination light to an irradiated plane through this closed space, While changing the concentration of said gas in said closed space according to said illumination distribution information from a detection means to detect the illumination distribution information on said irradiated plane, and said detection means Said light source is controlled, the wavelength of said illumination light is changed, and it has an amendment means to adjust the illumination distribution on said irradiated plane.

[0042] In the example of 1 mode of the lighting system of this invention, it is constituted so that two or more kinds of gases containing the gas in which said closed space has the property which absorbs said illumination light may be enclosed with the interior.

[0043] The example of 1 mode of the lighting system of this invention has two or more said closed space, and may change independently the state of matter which constitutes inner each fluid of said closed space.

[0044] The projection aligner of this invention is a projection aligner which exposes a predetermined pattern to the wafer side which is an irradiated plane, and is equipped with said lighting system for irradiating the illumination light at the reticle in which it comes to form the similarity pattern of said predetermined pattern, and the projection optics which projects said similarity pattern of said reticle on said wafer side so that it may become said predetermined pattern.

[0045] The manufacture approach of the semiconductor device of this invention is equipped with the step which applies sensitive material to a wafer side, the step which exposes a predetermined pattern to said wafer side where said sensitive material was applied using said projection aligner, and the step which develops said sensitive material with which exposure of said predetermined pattern was performed.

[0046]

[Function] In the lighting system of this invention, in case the illumination light injected from the light source passes through the inside of a closed space, depending on the condition of the wavelength of the illumination light, or the fluid in a closed space, the illumination light is absorbed with the fluid concerned and an illuminance falls. Here, since a closed space is constituted so that the absorption coefficients of the illumination light may differ so that the optical path length of the illumination light may change with locations through which the illumination light passes namely, the illumination light

which passed through the closed space concerned illuminates an irradiated plane with the distribution from which an illuminance differs partially. In this invention, it becomes possible about the illuminance nonuniformity of an irradiated plane to acquire homogeneous high illumination distribution extremely on phase murder and the irradiated plane concerned by changing the state of matter which constitutes the fluid in a closed space using this property, or changing wavelength of the illumination light and adjusting the illumination distribution on an irradiated plane.

[0047] Here, as a suitable thing, the mixture of gas which contains oxygen, for example is mentioned by the fluid enclosed in a closed space. In this case, illumination distribution is changeable by adjusting the concentration (partial pressure) of oxygen, or seting the concentration of oxygen constant and changing wavelength of the illumination light. Since gaseous concentration can be adjusted comparatively easily and correctly, it becomes possible [equalizing illumination distribution with high precision].

[0048] Moreover, as the example, the amendment optical system equipped with the closed space concerned may be installed independently that what is necessary is just to prepare a closed space between the light source and an irradiated plane, or a part of space formed in the lens group which makes it point to the illumination light to an irradiated plane may be used. Thus, in the lighting system of this invention, corresponding to the configuration of the light source and lens group, the physical relationship of an irradiated plane, the degree of illumination distribution, etc., according to a case, the closed space of the best gestalt can be established in various parts, and fine illumination distribution adjustment is attained.

[0049]

[Embodiment of the Invention] Some suitable operation gestalten which applied this invention to the projection aligner of the contraction mold called a stepper hereafter are explained.

[0050] (1st operation gestalt) The 1st operation gestalt is explained first. Drawing 1 is the mimetic diagram showing the main configurations of the stepper of the 1st operation gestalt. This stepper has the lighting system 20 for irradiating the illumination light at the reticle 11 on which the desired pattern was drawn, the projection optics 12 for carrying out contraction projection of the pattern of the reticle 11 concerned on the front face of a wafer 13 by the illumination light which passed the reticle 11 carrying out incidence, the wafer chuck 14 by which installation immobilization of the wafer 13 is carried out, and the wafer stage 15 where the wafer chuck 14 is fixed.

[0051] The lighting system 20 has the illuminance nonuniformity controller for adjusting the optical system for making the predetermined part on a reticle 11 point to the illumination light, and the illumination distribution of the illumination light in the front face of a wafer 13.

[0052] The light source 1 to which said optical system emits the ArF excimer laser light of high brightness as illumination light short wave Nagamitsu, such as ultraviolet rays and far ultraviolet rays, and here, A shape-of-beam conversion means 2 to change the illumination light from the light source 1 into a desired flux of light configuration, The optical integrator 3 which it comes to arrange two-dimensional in two or more cylindrical lenses and microlenses, The converging section material 4 arranged near the location of the secondary light source which the change to drawing of arbitration of was enabled by change means by which it does not illustrate, and was formed by the optical integrator 3, The condenser lens 5 which condenses the illumination light which passed the converging section material 4, and a half mirror 6, For example, the blind 7 which is constituted by the adjustable blade of four sheets, is arranged in the conjugation side of a reticle 11, and determines the lighting range of the front face of a reticle 11 as arbitration, The image formation lens 8 for projecting the illumination light determined as the predetermined configuration with the blind 7 on the front face of a reticle 11, It has the bending mirror 9 which reflects the illumination light from the image formation lens 8 in the direction of a reticle 11, and the amendment optical system 10 to which it bends with a reticle 11 and is arranged between mirrors 9, the mixture of gas is enclosed with so that it may mention later, and absorption of the illumination light is carried out.

[0053] With the light exposure monitor 17 which acts as the monitor of the illuminance of the front face of a wafer 13 indirectly when said illuminance nonuniformity controller measures a part of illumination light reflected by the half mirror 6 The illuminance measuring instrument 16 which measures the

illuminance and illumination distribution on the front face of the direct wafer 13 by being prepared on the stage 15, moving a stage 15, and bringing on an exposure side, The illuminance nonuniformity detector 18 which detects illumination distribution numerically based on the information from the illuminance measuring instrument 16 and the light exposure monitor 17, The amendment optical system 10 is controlled based on the detection result of the illuminance nonuniformity detector 18, and it has the exposure nonuniformity amendment circuit 19 which adjusts the illumination distribution in the front face of a wafer 13 so that it may become uniform, and is constituted.

[0054] The actuation which carries out contraction projection of the pattern of a reticle 11 on the front face of a wafer 13 is explained using the stepper constituted as mentioned above.

[0055] First, after the illumination light emitted from the light source 1 is changed into a predetermined configuration with the shape-of-beam conversion means 2, the optical integrator 3 points to it. At this time, two or more secondary light sources are formed near [that] the injection side. After being condensed by the condenser lens 5 through the converging section material 4, and the illumination light from this secondary light source passing a half mirror 6 and determining it as a predetermined configuration with a blind 7, it bends through the image formation lens 8, and reflects by the mirror 9, and incidence is carried out to the amendment optical system 10.

[0056] Then, the illumination light through the amendment optical system 10 passes the pattern of a reticle 11, and carries out incidence to projection optics 12. And projection optics 12 is passed, said pattern is reduced to a predetermined dimension, it is projected on the front face of a wafer 13, and exposure is given.

[0057] Here, the illuminance nonuniformity of the illumination light may arise in the front face of a wafer 13. This illuminance nonuniformity has some which generate besides various factors (thing of equipment immobilization) which were mentioned above also by modification (for example, modification of the converging section material 4) of a lighting condition, and are depended on aging. The amendment optical system 10 is for amending the illuminance nonuniformity which makes these a factor. That is, it adjusts so that the exposure nonuniformity amendment circuit 19 may drive the amendment optical system 10 and may become uniform [the illumination distribution concerned] using the illumination distribution of wafer 13 front face computed based on the information from the illuminance measuring instrument 16 and the light exposure monitor 17 (here, the light exposure monitor's 17 output may be used as a reference at the time of illuminance nonuniformity measurement).

[0058] Hereafter, the principle of the illumination distribution amendment by the amendment optical system 10 is explained using drawing 2 . This drawing 2 is the property Fig. showing an example of the measurement result of the wavelength intensity distribution of a certain ArF excimer laser light. Wavelength intensity distribution when a broken line fills 1.5m with air for wavelength intensity distribution when a drawing solid line fills the inside of an optical path with nitrogen among an optical path are expressed. On the wavelength which a difference on the strength does not produce in nitrogen-gas-atmosphere mind and air, it turns out conversely like about 193.3nm that absorption with air is large with wavelength with a strong large difference in nitrogen-gas-atmosphere mind and air, without producing most absorption with air. It is thought that most depends the difference of this absorption on oxygen.

[0059] Therefore, the light absorption of arbitration can be obtained the wavelength of the range which the absorption difference between oxygen and nitrogen produces, and by specifically choosing the predetermined wavelength of 192nm - about 194nm within the limits, and changing the oxygen density in an optical path (or concentration of air). That is, it becomes possible to make arbitration decrease the quantity of light near the optical-path trailer.

[0060] The example of the amendment optical system 10 in which this principle was used is shown in drawing 3 . Here, the inclination component (inclination nonuniformity) of illuminance nonuniformity is amended, and since it is easy, it explains that the amendment optical system 10 is arranged near the front face of a reticle 11. in drawing 3 , it is divided into two rooms (closed space) 10a and 10b by the light transmission members 10c, 10d, and 10e, such as a plane-parallel plate of a quartz, and air holes 31a and 31b form in room 10a, and air holes 32a and 32b form the amendment optical system 10 in room 10b --

having -- these air holes -- the gaseous mixture of each room -- it is constituted so that the ratio of a body constituent may be controlled independently. The mixture of gas consists of nitrogen, oxygen or nitrogen, and air. 10d of light transmission members is the thing of the planar structure which inclined to the plane of incidence of the illumination light La, Lb, and Lc which carries out incidence like illustration. The illumination distribution in an irradiated plane is amended by controlling the oxygen density of each part stores 10a and 10b.

[0061] Here, the wavelength which has some absorption to oxygen about the ArF excimer laser light of the light source 1 is chosen. When it is the wavelength which absorption does not produce at all to air, such as oxygen and clean air, illuminance nonuniformity as shown in this operation gestalt cannot be amended.

[0062] Usually, when not amending illumination distribution, two rooms 10a and 10b shown in drawing 3 are filled with nitrogen. Suppose that it was in the flat (there is no inclination nonuniformity) condition as the illumination distribution in the point plane of incidence (drawing Nakagami side) of the amendment optical system 10 showed by drawing 4 (a) now. Since the absorption of light does not occur when Rooms 10a and 10b are filled with nitrogen at this time, the illumination distribution configuration in the irradiation labor attendant of the amendment optical system 10 is still flat like drawing 4 (b). Even if some light absorption breaks out with nitrogen, since the absorption coefficient is the same, a distribution configuration will become flat with as to the illumination light of illumination light La, Lb, and Lc.

[0063] Now, a part of nitrogen of room 10b is permuted by oxygen (or air). Then, when the illumination light passes room 10b, light absorption occurs. Since the distance of the illumination light La, Lb, and Lc at the time of passing room 10b is La<Lb<Lc, a difference arises in the amount absorbed, respectively and, as for the illumination distribution in the irradiation labor attendant of the amendment optical system 10, the bottom of a right shoulder becomes distribution of ** like drawing 4 (c). It depends for this inclination on the oxygen density of room 10b.

[0064] Drawing 4 (d) is the property Fig. showing the illumination distribution at the time of making the oxygen density in room 10a increase where the inside of room 10b is filled with nitrogen. Thus, the inclination nonuniformity in an irradiation labor attendant is changeable into arbitration by controlling one [at least] oxygen density appropriately among Rooms 10a and 10b.

[0065] When illumination distribution becomes uneven on the front face of a wafer 13 according to various factors using such a property acquired by establishing the amendment optical system 10, for example, when becoming distribution like drawing 4 (c), by performing adjustment like drawing 4 (d), uneven illumination distribution will be offset, for example, uniform distribution will be attained like drawing 4 (a). Of course, what is necessary is just to perform adjustment like drawing 4 (c), case [like drawing 4 (d)].

[0066] Although 10d of light transmission members which divide the amendment optical system 10 into two rooms (closed space) is leaned in the parallel direction to the space of drawing 3 with this operation gestalt, it may lean in the perpendicular direction to space, and illuminance nonuniformity may be amended in the direction. The direction to which 10d of light transmission members is leaned is arbitrary, for example, it makes arbitration rotate the direction to lean and you may make it amend illuminance nonuniformity in the direction. Of course, it is also suitable to arrange two or more amendment optical system as shown in drawing 3 , and to perform independently inclination nonuniformity amendment to two or more directions, respectively.

[0067] Another gestalt of the amendment optical system of illuminance nonuniformity is shown in drawing 5 . 101d of transparency members into which the amendment optical system 101 in this another gestalt divides Rooms 101a and 101b has not a plane-parallel plate but the curved-surface configuration. Room 101a within the amendment optical system 101 has the amount of thin core to the direction of an optical axis, and the circumference part is thick. To it, room 101b has the amount of thick core, and the circumference part is thin. Air holes 102a and 102b are formed in room 101a, air holes 103a and 103b are formed in room 101b, respectively, and the ratio of a mixture-of-gas component is controlled by these air holes.

[0068] Drawing 6 shows the illumination distribution when changing the oxygen density of each part stores 101a and 101b in the amendment optical system 101.
[0069] Suppose that it was in the flat condition as the illumination distribution in the point plane of incidence (top face) of the amendment optical system 101 showed by drawing 6 (a) now. Since the absorption of light does not occur when each part stores 101a and 101b are filled with nitrogen at this time, the illumination distribution in the irradiation labor attendant of the amendment optical system 101 is still flat like drawing 6 (b). Even if light absorption breaks out with nitrogen, since the absorption coefficient is the same, a distribution configuration will become flat with as to illumination light Ld, Le, and Lf.
[0070] Here, a part of nitrogen in room 101b is permuted by oxygen (or air). Then, when the illumination light passes room 101b, light absorption occurs. Since the illumination light Le of a core of the distance of the illumination light Ld, Le, and Lf at the time of passing room 101b is longer than the illumination light Ld and Lf of a periphery, a difference arises in the amount absorbed, respectively, and the illumination distribution in the irradiation labor attendant of the amendment optical system 101 turns into distribution with a low core like drawing 6 (c). It depends for the absorption coefficient of this illumination light on the oxygen density in room 101b.
[0071] Drawing 6 (d) is the property Fig. showing the illumination distribution at the time of making the oxygen density in room 101a increase where the inside of room 101b is filled with nitrogen. Thus, the ratio (illuminance for a core) of the circumference illuminance in an irradiation labor attendant is changeable by controlling suitably the oxygen density of each part stores 101a and 101b.
[0072] As explained above, in case the illumination light injected from the light source 1 passes the amendment optical system 10 (101) in the stepper of the 1st operation gestalt, the illumination light is absorbed by the oxygen (or air) within the amendment optical system 10 (101) concerned, and an illuminance falls. Here, since the amendment optical system 10 (101) is constituted so that the absorption coefficients by oxygen may differ so that the optical path length of said illumination light may change with locations through which the illumination light passes namely, the illumination light which passed the amendment optical system 10 (101) concerned illuminates the front face of the wafer 13 which is an irradiated plane with the distribution from which an illuminance differs partially. With this operation gestalt, using this property, the oxygen density within the amendment optical system 10 (101) is changed, and it becomes possible by adjusting the illumination distribution on an irradiated plane to acquire homogeneous high illumination distribution extremely on phase murder and the irradiated plane concerned about the illuminance nonuniformity of an irradiated plane. Therefore, according to this stepper, since exposure becomes possible by homogeneous high illumination distribution extremely, it will contribute to highly precise micro processing.
[0073] In addition, in this operation gestalt, as for the permutation of an ambient atmosphere component, it is desirable to carry out about what has a small refractive-index difference, for example, it is desirable. [of a permutation with a vacuum, nitrogen, air, oxygen, an argon helium, hydrogen, etc.] However, in the case of optical system from which a refractive-index difference does not become a problem, there may be a permutation of this not a limitation but water and air etc.
[0074] Moreover, although an ArF excimer laser is used as the light source 1 and oxygen is used as an example as an absorbing material with this operation gestalt, it is F2, for example. You may also choose the thing of arbitration as an absorption gas, using laser as the light source. Of course, you may control by changing only the humidity of an ambient atmosphere component.
[0075] Here, some modifications of the 1st operation gestalt are explained. In addition, the same sign is described about the same thing as each part material which constitutes the stepper of the 1st operation gestalt, and explanation is omitted.
[0076] - Modification 1 - A modification 1 is explained first. Here, the oxygen (or air) which consists in a closed space between each lens in the lens barrel of a condenser lens 5 is permuted instead of establishing the amendment optical system 10 (101) as shown in drawing 3 or drawing 5 . That is, as shown in drawing 7 , in the lenses 5a, 5b, and 5c which constitute a condenser lens 5, closed space 5d and 5e is formed between lens 5a and 5b and between lens 5b and 5c. The distance in which the flux of

light from [from the configuration of Lenses 5a, 5b, and 5c] the light source 1 passes through closed space 5d and 5e with the passage location differs. In the modification 1, using this property, 5d of closed space and the oxygen (or air) concentration in 5e are adjusted, and the illumination distribution in an irradiated plane is adjusted to homogeneity like the case where the amendment optical system 10 is established, by the air holes 41a and 41b prepared in closed space 5d and 5e, and 42a and 42b.
[0077] In addition, in order to attain uniform illumination distribution, as drawing 3 and drawing 5 showed, the case where amendment optical system is established near the irradiated plane is the most effective, but since a difference will arise in illumination distribution if a difference is in absorption of the illumination light between the flux of lights which carry out incidence to each point of an irradiated plane, it may change into the condition (control of an oxygen density etc. can be performed) that the optical system of the arbitration from the light source 1 to an irradiated plane can be permuted, and illumination distribution may be amended. It is also suitable to amend by two or more optical system, of course.
[0078] - Modification 2 - Subsequently a modification 2 is explained. the amendment optical system 10 (101) as here shown in drawing 3 or drawing 5 -- in addition, the illuminance of the light from the light source 1 itself is controlled.
[0079] Conventionally, when the quantity of light from the light source 1 was adjusted, to be shown in drawing 8 , two or more ND filters 21a-21h from which permeability is different in an optical path are arranging the turret 21 prepared in the shape of radii, rotating this turret 21, and choosing the ND filter corresponding to the desired quantity of light, and were controlling the quantity of light. However, control of the quantity of light can perform only discontinuous control inevitably in this case depending on the number of ND filters.
[0080] To be shown in drawing 9 , when an internal oxygen density changes an oxygen density using the chamber 22 made adjustable, the quantity of light is controlled by this modification 2. This chamber 22 is formed between the light source 1 in drawing 1 , and the shape-of-beam conversion means 2. The illumination light from the light source 1 passes the open air and the intercepted chamber 22, and the front face of a wafer 13 points to it through the above-mentioned optical system. The chamber 22 is intercepted from the open air by the plane-parallel plates 22a and 22c with which an incident ray consists of the fully penetrated quality of the material, and controls the oxygen density of the internal 22b by air holes 51a and 51b.
[0081] By using this chamber 22, an oxygen density is controlled, light absorption is generated and the reinforcement of the flux of light injected from internal 22c can be controlled. A chamber 22 is controlled by the exposure nonuniformity amendment circuit 19 like the amendment optical system 10, it will act as the monitor of the illuminance by the illuminance measuring instrument 16 or the light exposure monitor 17, and the oxygen density of internal 22b of a chamber 22 will be controlled if needed. Therefore, still finer illumination distribution control is attained by using a chamber 22 together with the amendment optical system 10. Of course, it is also possible to form a chamber 22 independently and to perform light control, without using together with the amendment optical system 10 if needed.
[0082] (2nd operation gestalt) Then, the 2nd operation gestalt of this invention is explained. With the 1st operation gestalt, although the wavelength of the light source amended illuminance nonuniformity by changing ratios, such as oxygen, without changing, in the 2nd operation gestalt, it makes the oxygen within amendment optical system etc. the fixed ratio, and illustrates it about the case where illumination distribution is changed, by shaking the wavelength of the light source. In addition, the same sign is described about the same thing as the member which constitutes the stepper of the 1st operation gestalt, and explanation is omitted.
[0083] Drawing 10 is the mimetic diagram showing the main configurations of the stepper of the 2nd operation gestalt. Although this stepper has the same configuration as it of the 1st operation gestalt shown in drawing 1 , and abbreviation, the exposure nonuniformity amendment circuit 19 is connected also with the light source 1 with the 2nd operation gestalt.
[0084] As shown in drawing 2 , the rate of the absorption of light from the light source 1 over oxygen (air) is delicately different on each wavelength. For example, on a certain wavelength, the absorption

coefficient over air and nitrogen does not change at all, and both have a big difference on a certain wavelength, and it can change said absorption coefficient continuously by changing wavelength among these.
[0085] It follows, for example, oxygen is put into room 10a of the amendment optical system 10 of drawing 3 so that it may become fixed concentration, and room 10b can change illumination distribution continuously as a condition filled with nitrogen by changing the wavelength of the light source 1 within the limits of 192nm - 194nm. The illumination distribution of the illumination light in the front face of a wafer 13 can be adjusted to homogeneity like the case of the 1st operation gestalt using this property by controlling the wavelength of the illumination light from the light source 1 by the exposure nonuniformity amendment circuit 19.
[0086] In the stepper of this 2nd operation gestalt, in case the illumination light injected from the light source 1 passes the amendment optical system 10, the illumination light is absorbed by the oxygen within the amendment optical system 10 concerned (or air) according to the wavelength of the illumination light, and an illuminance falls. Here, since the amendment optical system 10 is constituted so that the absorption coefficients of the illumination light may differ so that the optical path length of the illumination light may change with locations through which the illumination light passes namely, the illumination light which passed the amendment optical system 10 concerned illuminates the front face of the wafer 13 which is an irradiated plane with the distribution from which an illuminance differs partially. With this operation gestalt, it becomes possible by changing the wavelength of the light source 1 to acquire homogeneous high illumination distribution extremely on phase murder and the irradiated plane concerned about the illuminance nonuniformity of an irradiated plane by adjusting the illumination distribution on an irradiated plane, maintaining the oxygen density within the amendment optical system 10 at predetermined constant value using this property. Therefore, according to this stepper, since exposure becomes possible by homogeneous high illumination distribution extremely, it will contribute to highly precise micro processing.
[0087] In addition, this invention is not limited to the 1st and 2nd operation gestalt or many modifications which were mentioned above. For example, in consideration of the both sides of the 1st and 2nd operation gestalten, the compound approach that the wavelength of the light from the light source 1 is also changed is also considered, changing the ratio of the oxygen density within the amendment optical system 10 (the configuration which can respond also to that is shown in drawing 10 for convenience.). According to this technique, since still finer illumination distribution control is attained, uniform illumination distribution is acquired more correctly and the highly precise stepper who can fully apply also to the further micro processing is realized.
[0088] In the above, the illumination distribution in an irradiated plane was controlled and how to attain uniform lighting distribution has been described. However, in the case of the scanning aligner which is becoming the current mainstream, it is not necessary to necessarily make the whole surface of an irradiated plane into homogeneity. In the case where this invention is applied to a scanning aligner, since there should just be no exposure nonuniformity in the result which carried out scan exposure, the nonuniformity to a scanning direction can be disregarded to some extent. Moreover, if the addition quantity of light to a scanning direction is the same about each location (each location of the direction which intersects perpendicularly with a scan), it is good, therefore it is sufficient to make illumination distribution adjustable only in the direction which intersects perpendicularly with a scanning direction.
[0089] Next, an example using the projection aligner explained using drawing 1 and drawing 10 of the manufacture approach of a semiconductor device (semiconductor device) is explained.
[0090] Drawing 11 shows the flow of the production process of semiconductor devices (semiconductor chips, such as IC and LSI, or a liquid crystal panel, CCD, etc.). First, the circuit design of a semiconductor device is performed at step 1 (circuit design). The mask in which the designed circuit pattern was formed is manufactured at step 2 (mask manufacture). On the other hand, at step 3 (wafer manufacture), a wafer is manufactured using ingredients, such as silicon. Step 4 (wafer process) is called a last process, and forms an actual circuit on a wafer with a photolithography technique using the mask and wafer which were prepared like the above. The following step 5 (assembly) is called a back process,

is a process semiconductor-chip-ized using the wafer produced by step 4, and includes processes, such as the Assen Puri process (dicing, bonding) and a PAKKE zinc process (chip enclosure). At step 6 (inspection), the check test of the semiconductor device produced at step 5 of operation, an endurance test, etc. are inspected. A semiconductor device is completed through such a process and this is shipped (step 7).

[0091] Drawing 12 shows the detailed flow of the above-mentioned wafer process. The front face of a wafer is oxidized at step 11 (oxidation). An insulator layer is formed in a wafer front face at step 12 (CVD). At step 13 (electrode formation), an electrode is formed by vacuum evaporationo on a wafer. Ion is driven into a wafer at step 14 (ion implantation). A sensitization agent is applied to a wafer at step 15 (resist processing). At step 16 (exposure), printing exposure of the circuit pattern of a mask is carried out at a wafer with the projection aligner which gave [above-mentioned] explanation. The exposed wafer is developed at step 17 (development). At step 18 (etching), parts other than the developed resist image are shaved off. The resist which etching was completed and became unnecessary is removed at step 19 (resist exfoliation). By carrying out by repeating these steps, a circuit pattern is formed on a wafer multiplex.

[0092] If this manufacture approach is used, the semiconductor device of a high degree of integration for which manufacture was difficult can be manufactured easily and certainly conventionally.

[0093]

[Effect of the Invention] According to the lighting system of this invention, it becomes possible about stopping the illuminance nonuniformity in an irradiated plane small, and attaining uniform illumination distribution, without performing eccentricity of optical system etc.

[0094] Moreover, if a projection aligner is constituted using this lighting system, extremely, exposure can become possible, the request of the further highly precise micro-processing-izing in recently can fully be filled with homogeneous high illumination distribution, and high-reliability can be acquired.

[Translation done.]